PHYTOPLANKTON OF UTAH LAKE

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Abstract.— The plankton flora of Utah Lake includes a total of 295 species to date. This high number of taxa indicates greater diversity than previously suspected. Together with water chemical data it leads us to conclude that Utah Lake is a slightly saline eutrophic system. This conclusion is further substantiated by quantitative data which show very high levels of productivity during late summer and early fall.

Utah Lake is a shallow, eutrophic, slightly saline desert lake located in central Utah (Map 1). The deepest portion of the lake is no more than 4.2 m and the average depth is 2.8 m (Bingham 1974). The lake covers an area of 388 km² (Brown 1968). The water is highly turbid with Secchi disk readings averaging 24 cm and ranging from less than 12 to 50 cm. The lake is often classified as highly eutrophic due to the turbidity and dense algal blooms that occur essentially every year in the late summer and early fall.

The lake basin receives inflow from numerous mineral springs within and around the periphery of the lake. As a result, the water has a high carbonate and sulfate content. The total dissolved solids in the lake varied between 795 and 1650 mg/l from 1961 to 1978. At the present conductivity level (average 1400 μm) of the lake and assuming the same ions are present, the total dissolved solids range from 700 to 1000 mg/l during typical inflow years and lake levels. Lakes having between 1,000 and 3,000 mg/l of dissolved solids are described by the U.S. Geological Survey (Hem 1970) as being slightly saline.

Preliminary studies of zooplankton were conducted by Tanner (1931) and Hunt (1940), but little significant research has been done since. Likewise, few significant studies of the phytoplankton have been done. Harding (1970, 1971) published two algal lists in which he identified several phytoplankters as being present in the lake. However, his lists are incomplete, and particularly ignore the Bacillariophyta (diatoms).

This study provides a comprehensive list of all algae collected from the water column through 1978, together with descriptions of the major algal species present in Utah Lake. We are aware that many of these species, particularly many of the diatoms, are not true plankters. Even so, they represent important members of the floating algal assemblage and thus are reported herein.

Methods

Phytoplankton samples were collected at regular intervals during the summer of 1974 at 14 stations along three permanent transects (Map 1). The transects were chosen to represent three supposed subenvironments within the lake. Stations were established at approximately equal intervals along the transects. Each station was marked with buoys, and shore triangulation points were recorded so that the point could be relocated on each successive sampling date. The northern or Geneva transect ran west from the spillway of the settling pond of United States Steel's Geneva Works. It consisted of 5 stations. The middle or Provo Boat Harbor transect also had 5 stations. It ran west from a point just south of the mouth of Provo River and north of Provo Bay. The southern or Goshen Bay transect, with only 4 stations, ran west from Ludlow's sheep barns near Lincoln Beach.

Samples were collected every nine days from 4 June 1974 to 15 August 1974. Sampling was always done in the morning in order to minimize diurnal variability. In addition, samples were collected on a less intensive basis during the spring and summer months of 1975 and 1976 and again with

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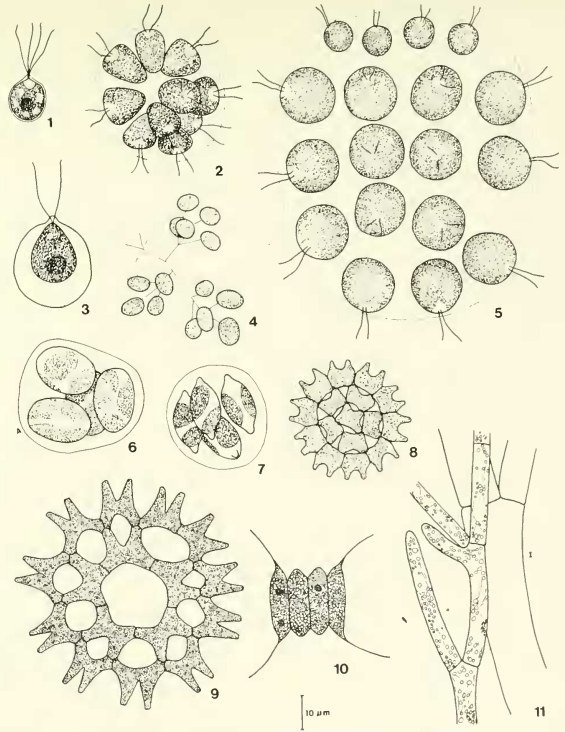
Map 1. Reference map of Utah Lake showing its position within the state, prominent shoreline features, and the location of three transects established within the lake for phytoplankton sampling.



Figs. 1–11: 1, *carteria stellifera*; 2, *Pandorina morum*; 3, *Sphaerellopsis aulata*; 4, *Dictyosphaerium ehrenbergianum*; 5, *Pleodorina illinoisensis*; 6, *Oocystic borgei*; 7, *Oocystis lacustris*; 8, *Pediastrum duplex*; 9, *Pediastrum duplex* var. *gracilimum*; 10, *Scenedesmus quadricauda* var. *longispina*; 11, *Cladophora glomerata*. All figures except Fig. 11 are drawn to the same scale. Scales provided represent 10 µm.

greater intensity during the summer and fall of 1978.

The phytoplankton was sampled by pouring known volumes of water through a 64 μm mesh net. The water was dipped from the lake with a 10-liter bucket. The amount of water poured through the net varied as the summer progressed because the amount of algae in a given volume of water increased during bloom periods. In most cases, algae were identified and counted immediately upon returning to the laboratory, but in all cases within 48 hours of collection.

Laboratory analysis consisted of identifying and counting the algae present in phytoplankton samples. Algal samples were subsampled, the organisms present were identified to species, and the frequency of each organism was recorded. Components of the phytoplankton were first counted in Palmer counting cells at 400X and the numbers of organisms in the original lake water were calculated by multiplication factors. Since diatoms cannot usually be identified to species in wet mount slides, permanent diatom slides were made using Naphrax mounting medium and standard oxidation methods (St. Clair and Rushforth 1976). The diatoms were counted and the relative frequency of each species was calculated.

RESULTS

A total of 295 phytoplankters has been identified from Utah Lake (Table 1). Species described below represent some of those most commonly encountered during our studies. Each is given a brief description and a summary of collection data. In addition, a reference to a complete description of the organism is provided.

Division: Chlorophyta

ORDER: VOLVOCALES

Carteria stellifera Nygaard (Fig. 1). Plant unicellular; cells spherical to subspherical with slight apical papilla from which the four flagella arise, 10–20 μm in diameter, 12.5–22.5 μm long (Thienemann 1961:95). Abundant at the mouth of the Provo River throughout the summer months and occasionally important locally in other parts of the lake.

TABLE 1. Phylogenetic list of algae collected from the water column in Utah Lake 1974–1978.

CHLOROPHYTA

Chlorophyceae
- Volvocales
  - Chlamydomonadaceae
    - *Carteria cordiformis* (Carter) Dill
    - *Carteria klebsii* (Dang.) Francé *em.* Troitzkaja
    - *Carteria stellifera* Nygaard
    - *Chlamydomonas altera* Skuja
    - *Chlamydomonas globosa* Snow
    - *Chlamydomonas polypyrenoideum* Prescott
    - *Sphaerellopsis aulata* (Pascher) Gerloff
  - Phacotaceae
    - *Wislouchiella planctonica* Skvortzow
  - Volvocaceae
    - *Pandorina morum* (Muell.) Bory
    - *Pleodorina illinoisensis* Kofoid
- Tetrasporales
  - Palmellaceae
    - *Sphaerocystis schroeteri* Chodat
- Ulotrichales
  - Chaetophoraceae
    - *Stigeoclonium stagnatile* (Hazen) Collins
- Cladophorales
  - Cladophoraceae
    - *Cladophora glomerata* (Lemm.) Kuetzing
- Chlorococcales
  - Micractiniaceae
    - *Micractinium pusillum* Fresenius
  - Dictyosphaeriaceae
    - *Dictyosphaerium ehrenbergianum* Naegeli
  - Characiaceae
    - *Ankyra judayi* (G. M. Smith) Fott.
    - *Schroederia setigera* (Schroeder) Lemmermann
  - Hydrodictyaceae
    - *Pediastrum boryanum* (Turp.) Meneghini
    - *Pediastrum duplex* Meyen
    - *Pediastrum duplex* var. *brachylobum* A. Braun
    - *Pediastrum duplex* var. *clathratum* (A. Braun) Lagerheim
    - *Pediastrum duplex* var. *gracilimum* West & West
    - *Pediastrum simplex* (Meyen) Lemmermann
    - *Pediastrum simplex* var. *duodenarium* (Bailey) Rabenhorst
    - *Pediastrum tetras* (Ehr.) Ralfs
    - *Pediastrum tetras* var. *tetraodon* (Corda) Hansgirg
  - Coelastraceae
    - *Coelastrum microporum* Naegeli
  - Oocystaceae
    - *Ankistrodesmus convolutus* Corda
    - *Ankistrodesmus falcatus* (Corda) Ralfs
    - *Ankistrodesmus falcatus* var. *mirabilis* (West & West) G. S. West
    - *Ankistrodesmus falcatus* var. *stipitatus* (Chod.) Lemmermann
    - *Closteriopsis longissima* var. *tropica* West & West
    - *Kirchneriella lunaris* (Kirch.) Moebius
    - *Lagerheimia longiseta* var. *major* G. M. Smith
    - *Lagerheimia wratislawiensis* Schroeder

Table 1 continued.

- *Oocystis borgei* Snow
- *Oocystis elliptica* W. West
- *Oocystis gigas* Archer
- *Oocystis gloeocystiformis* Borge
- *Oocystis lacustris* Chodat
- *Oocystis novae-semliae* Wille
- *Oocystis parva* West & West
- *Oocystis pusilla* Hansgirg
- *Oocystis submarina* Lagerheim
- *Quadrigula lacustris* (Chod.) G. M. Smith
- *Selenastrum bibraianum* Reinsch
- *Selenastrum gracile* Reinsch
- *Selenastrum westii* G. M. Smith
- *Treubaria triappendiculata* Bernard

Scenedesmaceae
- *Actinastrum hantzschii* Lagerheim
- *Actinastrum hantzschii* var. *fluviatile* Schroeder
- *Crucigenia quadrata* Morren
- *Crucigenia tetrapedia* (Kirch.) West & West
- *Scenedesmus abundans* var. *brevicauda* G. M. Smith
- *Scenedesmus acuminatus* (Lagerheim) Chodat
- *Scenedesmus bijuga* var. *alterans* (Reinsch) Hansgirg
- *Scenedesmus bijuga* var. *flexuosus* Lemmermann
- *Scenedesmus dimorphus* (Turp.) Kuetzing
- *Scenedesmus longus* var. *naegelii* (de Bréb.) G. M. Smith
- *Scenedesmus opoliensis* P. Richter
- *Scenedesmus perforatus* Lemmermann
- *Scenedesmus quadricauda* (Turp.) de Brébisson
- *Scenedesmus quadricauda* var. *longispina* (Chod.) G. M. Smith

Zygnematales
Desmidaceae
- *Closterium* sp.
- *Staurastrum paradoxum* Meyen
- *Staurastrum tetracerum* Ralfs

CHRYSOPHYTA

Xanthophyceae
Tribonematales
Tribonemataceae
- *Tribonema bombycinium* (C. A. Ag.) Derbes & Solier

Chrysophyceae
Chrysomonadales
Ochromonadaceae
- *Dinobryon bavaricum* Imhof
- *Dinobryon divergens* Imhof
- *Dinobryon sociale* var. *americanum* (Brunn.) Bachmann

Mallomonadaceae
- *Mallomonas acaroides* Perty
- *Mallomonas caudata* Iwanoff
- *Mallomonas pseudocoronata* Prescott
- *Mallomonas tonsurata* Teiling

Table 1 continued.

BACILLARIOPHYTA

Bacillariophyceae
Biddulphiales
Biddulphiaceae
- *Biddulphia laevis* Ehrenberg

Chaetoceraceae
- *Chaetoceros elmorei* Boyer

Coscinodiscales
Coscinodiscaceae
- *Coscinodiscus lacustris* Grunow.
- *Cyclotella antiqua* W. Smith
- *Cyclotella bodanica* Eulenstein
- *Cyclotella kutzingiana* Thwaites
- *Cyclotella meneghiniana* Kuetzing
- *Cyclotella ocellata* Pantocsek
- *Cyclotella stelligera* Cleve and Grunow
- *Melosira granulata* (Ehr.) Ralfs
- *Melosira granulata* var. *angustissima* O. Mueller
- *Melosira italica* (Ehr.) Kuetzing
- *Melosira varians* Agardh
- *Stephanodiscus astrea* (Ehr.) Grunow
- *Stephanodiscus astrea* var. *minutula* (Kuetzing) Grunow
- *Stephanodiscus niagarae* Ehrenberg
- *Thalassiosira* sp.

Fragilariales
Fragilariaceae
- *Asterionella formosa* Hassall
- *Diatoma tenue* Agardh
- *Diatoma tenue* var. *elongatum* Lyngbye
- *Diatoma vulgare* Bory
- *Diatoma vulgare* var. *grande* (W. Sm.) Grunow
- *Fragilaria brevistriata* Grunow
- *Fragilaria brevistriata* var. *capitata* Heribaud
- *Fragilaria brevistriata* var. *inflata* (Pant.) Hustedt
- *Fragilaria construens* (Ehr.) Grunow
- *Fragilaria construens* var. *binodis* (Ehr.) Grunow
- *Fragilaria construens* var. *pumila* Grunow
- *Fragilaria construens* var. *venter* (Ehr.) Grunow
- *Fragilaria crotonensis* Kitton
- *Fragilaria leptostauron* (Ehr.) Hustedt
- *Fragilaria vaucheriae* (Kuetz.) Petersen
- *Hannaea arcus* (Ehr.) Patrick
- *Ophephora martyi* Heribaud
- *Synedra capitata* Ehrenberg
- *Synedra delicatissima* var. *angustissima* Grunow
- *Synedra fasciculata* var. *truncata* (Grev.) Patrick
- *Synedra mazamaensis* Sovereign
- *Synedra rumpens* var. *familiaris* (Kuetz.) Grunow
- *Synedra rumpens* var. *fragilarioides* Grunow
- *Synedra rumpens* var. *scotica* Grunow
- *Synedra tenera* W. Smith
- *Synedra ulna* (Nitzsch) Ehrenberg
- *Synedra ulna* var. *contracta* Ostrup

Eunotiales
Eunotiaceae
- *Eunotia arcus* var. *bidens* Grunow

Achnanthales
Achnanthaceae
- *Achnanthes clevei* Grunow
- *Achnanthes deflexa* Reimer

Table 1 continued.

Achnanthes exigua Grunow
Achnanthes hauckiana Grunow
Achnanthes lanceolata (Breb.) Grunow
Achnanthes lanceolata var. *dubia* Grunow
Achnanthes linearis (W. Sm.) Grunow
Achnanthes minutissima Kuetzing
Cocconeis pediculus Ehrenberg
Cocconeis placentula var. *euglypta* (Ehr.) Cleve
Cocconeis placentula var. *lineata* (Ehr.) Van Heurck
Cocconeis diminuta (Pantocsek
Rhoicosphenia curvata (Kuetz.) Grunow
Naviculales
Naviculaceae
Anomoeoneis sphaerophora (Ehr.) Pfitzer
Caloneis amphisbaena (Bory) Cleve
Caloneis bacillum (Grun.) Cleve
Caloneis fenzlioides Cleve-Euler
Caloneis schumanniana (Grunow) Cleve
Diploneis oblongella (Naegeli *ex* Kuetz.) Ross
Diploneis pseudovalis Hustedt
Diploneis smithii var. *dilatata* (M. Perag.) Boyer
Diploneis smithii var. *pumila* (Grun.) Hustedt
Gyrosigma acuminatum (Kuetz.) Rabenhorst
Mastogloia elliptica var. *danseii* (Thwaites) Cleve
Navicula amphibola Cleve
Navicula arvensis Hustedt
Navicula aurora Sovereign
Navicula capitata Ehrenberg
Navicula capitata var. *hungarica* (Grun.) Ross
Navicula circumtexta Meist. *ex* Hustedt
Navicula crucicula (W. Sm.) Donk.
Navicula cryptocephala Kuetzing
Navicula cryptocephala var. *veneta* (Kuetz.) Rabenhorst
Navicula cuspidata (Kuetz.) Kuetzing
Navicula exigua Greg. *ex* Grunow
Navicula exigua var. *capitata* Patrick
Navicula graciloides A. Mayer
Navicula lanceolata (Ag.) Kuetzing
Navicula meniscullus var. *upsaliensis* (Grun.) Grunow
Navicula minima Grunow
Navicula minuscula Grunow
Navicula oblonga (Kuetz.) Kuetzing
Navicula pelliculosa (Breb. *ex* Kuetz.) Hilse
Navicula peregrina (Ehr.) Kuetzing
Navicula pupula Kuetzing
Navicula pupula var. *rectangularis* (Greg.) Grunow
Navicula pygmaea Kuetzing
Navicula radiosa Kuetzing
Navicula reinhardtii var. *elliptica* Heribaud
Navicula rhyncocephala Kuetzing
Navicula salinarum Grunow
Navicula salinarum var. *intermedia* (Grun.) Cleve
Navicula scutelloides W. Sm. *ex* Gregory
Navicula secreta var. *apiculata* Patrick
Navicula tenelloides Hustedt
Navicula tripunctata (Muell.) Bory
Navicula tuscula Ehrenberg

Table 1 continued.

Navicula viridula (Kuetz.) Kuetzing em. Van Heurck
Navicula sp.
Neidium iridis (Ehr.) Cleve
Pinnularia borealis var. *rectangularis* Carlson
Pinnularia brebissonii (Kuetz.) Rabenhorst
Pinnularia microstauron (Ehr.) Cleve
Pinnularia viridis (Nitzsch) Ehrenberg
Pleurosigma australe Grunow
Pleurosigma delicatulum W. Smith
Scoliopleura peisonis Grunow
Stauroneis phoenicentron (Nitzsch.) Ehrenberg
Cymbellaceae
Amphora coffeiformis (Agardh) Kuetzing
Amphora ovalis (Kuetz.) Kuetzing
Amphora ovalis var. *affinis* (Kuetz.) Van Heurck *ex* De Toni
Amphora perpusilla (Grun.) Grunow
Amphora veneta Kuetzing
Cymbella affinis Kuetzing
Cymbella cistula (Ehr.) Kirchner
Cymbella cymbiformis Agardh
Cymbella mexicana (Ehr.) Cleve
Cymbella microcephala Grunow
Cymbella minuta var. *silesiaca* (Bleisch *ex.* Rabh.) Reimer
Cymbella muelleri Hustedt
Cymbella prostrata (Berk.) Cleve
Cymbella sinuata Gregory
Cymbella tumida (Breb. *ex* Kuetz.) Van Heurck
Cymbella tumidula Grunow *ex* A. Schmidt
Cymbella sp. 1
Cymbella sp. 2
Gomphonemaceae
Gomphonema angustatum (Kuetz.) Rabenhorst
Gomphonema clevei Fricke
Gomphonema intricatum Kuetzing
Gomphonema olivaceum (Lyngb.) Kuetzing
Gomphonema parvulum Kuetzing
Gomphonema sphaerophorum Ehrenberg
Gomphonema truncatum Ehrenberg
Gomphonema ventricosum Greg.
Entimoneidaceae
Entomoneis alata (Ehr.) Ehrenberg
Plagiotropis vitrea (W. Smith) Grunow
Epithemiales
Epithemiaceae
Denticula elegans Kuetzing
Denticula elegans f. *valida* Pedic.
Epithemia sorex Kuetzing
Epithemia turgida (Ehr.) Kuetzing
Epithemia turgida var. *granulata* (Ehr.) Brun
Epithemia adnata (Kuetz.) Brebisson
Rhopalodia gibba (Ehr.) O. Mueller
Rhopalodia gibba var. *ventricosa* (Kuetz.) H. and M. Peragallo
Rhopalodia gibberula var. *protracta* Grunow
Rhopalodia musculus (Kuetz.) O. Mueller
Nitzschiales
Nitzschiaceae
Bacillaria paradoxa Gmelin
Cylindrotheca gracilis (Breb.) Grunow

Table 1 continued.

Hantzschia amphioxys (Ehr.) Grunow
Hantzschia amphioxys f. *capitata* O. Mueller
Nitzschia acicularis W. Smith
Nitzschia amphibia Grunow
Nitzschia apiculata (Greg.) Grunow
Nitzschia communis Rabenhorst
Nitzschia dissipata (Kuetz.) Grunow
Nitzschia filiformis (W. Smith) Hustedt
Nitzschia fonticola Grunow
Nitzschia frustulum (Kuetz.) Grunow
Nitzschia hantzschiana Rabenhorst
Nitzschia hungarica Grunow
Nitzschia linearis W. Smith
Nitzschia longissima var. *closterium* (W. Smith) Van Heurck
Nitzschia ovalis Arnott
Nitzschia palea (Kuetz.) W. Smith
Nitzschia paleacea Grunow
Nitzschia perminuta Grunow
Nitzschia punctata (W. Sm.) Grunow
Nitzschia sigmoidea (Ehr.) W. Smith
Nitzschia tryblionella Hantzsch
Nitzschia tryblionella var. *debilis* (Arnott) A. Mayer
Nitzschia tryblionella var. *genuina* Grunow
Nitzschia tryblionella var. *levidensis* (W. Sm.) Grunow
Nitzschia tryblionella var. *victoriae* Grunow
Surirellales
Surirellaceae
Camplyodiscus hibernicus Ehrenberg
Cymatopleura elliptica (Breb.) W. Smith
Cymatopleura solea (Breb.) W. Smith
Surirella angusta Kuetzing
Surirella ovalis Brebisson
Surirella ovalis var. *brightwellii* (W. Sm.) Cleve-Euler
Surirella ovata Kuetzing
Surirella striatula Turpin

EUGLENOPHYTA

Euglenophyceae
Euglenales
Euglenaceae
Euglena ehrenbergii Klebs
Euglena gracilis Klebs
Euglena oxyuris Schmarda
Euglena proxima Dangeard
Lepocinclis salina Fritsch
Phacus chloroplastes Prescott
Phacus tortus (Lemm.) Skvortzow
Strombomonas fluviatilis (Lemm.) Deflandre
Trachelomonas crebea Killicott—Deflandre

PYRROPHYTA

Dinophyceae
Peridiniales
Glenodiniaceae
Glenodinium dinobryonis (Woloszynska) Lindemann
Glenodinium penardiforme (Lindemann) Schiller

Table 1 continued.

Certiaceae
Ceratium hirundinella (Muell.) Dujardin

CYANOPHYTA

Myxophyceae
Chroococcales
Chroococcaceae
Anacystis rupestris (Lyngb.) Drouet & Daily
Chroococcus minutus (Kuetz.) Naegeli
Glococapsa punctata Naegeli
Gomphospheria aponina Kuetzing
Gomphospheria lacustris Chodat
Holopedium irregulare Lagerheim
Marssoniella elegans Lemmermann
Merismopedia glauca (Ehr.) Naegeli
Microcystis aureginosa Kutz. *em.* Elenkin
Microcystis incerta Lemmermann
Microcystis protocystis Crow
Hormogonales
Oscillatoriaceae
Lyngbya majusculla Harvey
Lyngbya martensiana Meneghini
Oscillatoria angustissima West & West
Oscillatoria articulata Gardner
Oscillatoria subbrevis Schmidle
Oscillatoria tenuis Agardh
Schizothrix lacustris A. Braun *ex* Kuetzing
Nostocaceae
Anabaena flos-aquae (Lyngbye) de Brébisson
Anabaena spiroides var. *crassa* Lemmermann
Aphanizomenon flos-aquae (Lemm.) Ralfs
Nostoc caeruleum Lyngbye

Pandorina morum (Muell.) Bory (Fig. 2). Colony ovate or obovoid, composed of 8–16 cells; cells compactly arranged and enclosed by common gelatinous matrix, compressed with broad anterior end directed outward; chloroplast a single parietal cup; cells about 10 μm in diameter; colony of 16 cells 29–37.5 μm in diameter, 38–40 μm long (Prescott 1962:75). Abundant in plankton from Provo River mouth and Provo Boat Harbor, rare to common in remainder of lake. Small colonies of about eight cells were often almost spherical in shape.

Pleodorina illinoisensis Kofoid (Fig. 5). Colony globose with 16–32 cells, 4 of which are small and vegetative; cells spherical, with 4 to 8 pyrenoids; vegetative cells about 8 μm in diameter; reproductive cells about 15 μm in diameter (Prescott 1962:77). Rare to abundant in plankton samples and especially abundant in samples from Provo River mouth.

Sphaerellopsis aulata (Pascher) Gerloff (Fig. 3). Plant unicellular and free swimming; cells teardrop shaped, widely rounded posteriorly and narrowly rounded anteriorly to acute apex, 10–15 μm in diameter, 15–20 μm long; chloroplast cup shaped and filling entire cell wall; eye spot red and often visible; sheath hyaline and very wide, often with apical papilla where flagella emerge. *Sphaerellopsis* differs from *Chlamydomonas* by its wide sheaths that narrow anteriorly and are not same shape as protoplast (Thienemann, 1961:452). Abundant in Provo River mouth in July and August.

ORDER: CHLOROCOCCALES

Dictyosphaerium ehrenbergianum Naegeli (Fig. 4). Colony spherical to ovoid, cells attached in groups of twos and fours at ends of very fine filaments; cells spherical to ellipsoid, 3–6 μm in diameter, 6–10 μm long; chloroplasts 1–2 parietal cups (Prescott 1962:238). Abundant in plankton samples from lake and Provo River mouth in early June, becoming less important in July and August.

Oocystis borgei Snow (Fig. 6). Plant unicellular or in groups of 2–6 enclosed by old mother cell wall; cells ellipsoid-ovate, with poles broadly rounded and without nodular thickenings; chloroplasts single parietal plates; cells 12–13 μm in diameter, 18–20 μm long; colony of four cells about 38 μm in diameter (Prescott 1962:243). Often the most common *Oocystis* in Utah Lake and common in our plankton samples throughout summer.

Oocystis lacustris Chodat (Fig. 7). Plant unicellular or a colony of four cells; mother cell ovoid or sometimes flattened at poles, about 10 μm in diameter, 17.5 μm long; chloroplasts 1–2; colony of four cells about 28μm long (Prescott 1962:245). Often common in plankton samples throughout lake. Can be distinguished by its definite polar papillae. Prescott (1962) mentioned that this alga is often collected in colonies of two to eight cells.

Pediastrum duplex Meyen (Fig. 8). Colony perforate with lens-shaped spaces between cells; inner cells shaped like short, fat H's; peripheral cells with inner margins more or less straight, outer margins concave with blunt-tipped, tapering processes; cells about 8 μm in diameter; colony with about 100 cells, 63 μm across (Prescott 1962:223). Abundant in early June but soon replaced by *P. duplex* var. *gracilimum*, which Prescott (1962) noted as a growth form of typical plant. Latter found throughout the summer.

Pediastrum duplex var. *gracilimum* West & West (Fig. 9). Colony with large perforations; body of cells narrow, equal in width to processes of peripheral cells; processes not tapering, or only slightly tapering; cells larger than typical plant, up to 25 μm in diameter (Prescott, 1962, p. 224). Rare in June but became more common in July and August.

Scenedesmus quadricauda var. *longispina* (Chod.) G. M. Smith (Fig. 10). Colony of 4–8 cells in one series; cells widely variable in size, 5–13 μm in diameter, 15–27 μm long, oblong-cylindric with lateral walls in full contact with adjacent cells; outer cells with long, curved spine at each pole; inner cells without spines (Prescott 1962:280). Abundant in plankton samples in late July and early August. Resembles *S. opoliensis* but separated on basis of amount of lateral wall contact between adjacent cells. Cells of *S. quadracauda* var. *longispina* in contact with adjacent cells along entire lateral walls.

ORDER: CLADOPHORALES

Cladophora glomerata (Lemm.) Kuetzing (Fig. 11). Filaments successively and regularly branched, branches usually crowded in outer parts of plant; cells cylindrical; apical cells attenuate slightly to a bluntly rounded end; cells of main axis 75–100 μm in diameter, six to seven times diameter in length; cells in branches 35–50 μm in diameter, three to six times diameter in length (Prescott, 1962:138). Found free-floating after becoming detached from rocks in splash zone along lake shore. This taxon was most important littoral alga in lake.

Division: Chrysophyta

ORDER: OCHROMONADALES

Dinobryon divergens Imhof (Fig. 52). Colonies much branched and widely diverging; loricas conical, posterior portion usually bent at an angle; lateral margins diverge then change direction, suddenly becoming convergent, then flare out again at mouth; loricas 7–8 μm in diameter, 32–40 μm long

(Prescott 1962:378). Most common *Dinobryon* species in our study. Most abundant at mouth of Provo River but common in some lake plankton samples.

Division: Bacillariophyta

ORDER: RHIZOSOLENIALES

Cyclotella kutzingiana Thwaites (Fig. 12). Cell diameter 8–13 μm; striae 16–20 in 10 μm (Hustedt 1930:98). Common throughout lake.

Cyclotella meneghiniana Kuetzing (Fig. 13). Cell diameter 10–13 μm; striae 6–9 in 10 μm (Hustedt 1930:100). One of most common species throughout lake.

Melosira granulata (Ehr.) Ralfs (Fig. 14). Cells 12–21 μm long by 7–18 μm wide; striae 6–12 in 10 μm (Hustedt 1930:87). Common throughout lake.

Melosira granulata var. *angustissima* Mueller (Fig. 15). Cells 12–17 μm long by 47 μm wide; striae 6–12 in 10 μm (Hustedt 1930:88). Can be collected in large numbers throughout lake. Together with nominate, probably most frequent and abundant of diatom species.

Melosira italica (Ehr.) Kuetzing (Fig. 16). Cells 12–13 μm long by 14–15 μm width; striae 17–18 in 10 μm (Hustedt 1930:91). Common in some years in the lake.

Melosira varians C. A. Agardh (Fig. 17). Cells 11–20 μm long by 11–14 μm wide (Hustedt 1930:85). Taken in low numbers from sites throughout lake.

ORDER: FRAGILARIALES

Diatoma vulgare Bory (Fig. 23). Cells 34–52 μm long by 11–12 μm wide; costae 5–8 in 10 μm; striae indistinct (Patrick and Reimer 1966:109). Throughout lake in low numbers.

Fragilaria brevistriata var. *inflata* (Pant.) Hustedt (Fig. 18). Cells 12 μm long by 4–5 μm wide; striae 14–17 in 10 μm (Patrick and Reimer 1966:129). Frequent throughout lake.

Fragilaria construens (Ehr.) Grunow (Figs. 19, 21, 22). Cells 9–18 μm long by 5–12 μm wide; striae 11–16 in 10 μm (Patrick and Reimer 1966:125). Quite common in Goshen Bay and midlake areas.

Fragilaria construens var. *venter* (Ehr.) Grunow (Fig. 20). Cells 6–7 μm long by 4–5 μm wide; striae 12 in 10 μm (Patrick and Reimer 1966:126). Common throughout lake.

Fragilaria crotonensis Kitton (Fig. 24). Cells 78–83 μm long by 3–4 μm wide; striae 13–15 in 10 μm (Patrick and Reimer 1966:121). Common at both Goshen and boat harbor areas and at scattered sites throughout south and midlake regions.

Fragilaria vaucheriae (Kuetz.) Petersen (Fig. 26). Cells 6–43 μm long by 4–6 μm wide; striae 11–16 in 10 μm (Patrick and Reimer 1966:120). Often collected abundantly throughout lake. Frustule shape is highly variable.

Asterionella formosa Hassall (Fig. 25). Cells 50–77 μm long by 2–3 μm wide; striae 30 in 10 μm (Patrick and Reimer 1966:159). In moderate numbers throughout entire lake early in spring and summer.

ORDER: ACHNANTHALES

Cocconeis placentula var. *lineata* (Ehr.) Van Heurck (Fig. 28). Cells 15–47 μm long by 10–30 μm wide; pseudoraphe valve striae 18–20 in 10 μm; raphe valve striae 19 in 10 μm (Patrick and Reimer 1966:242). Common in samples throughout lake.

Achnanthes minutissima Kuetzing (Fig. 29, 30). Cells 5–29 μm long by 3–5 μm wide; pseudoraphe and raphe valve striae 22–32 in 10 μm (Patrick and Reimer 1966:253). Common in many samples.

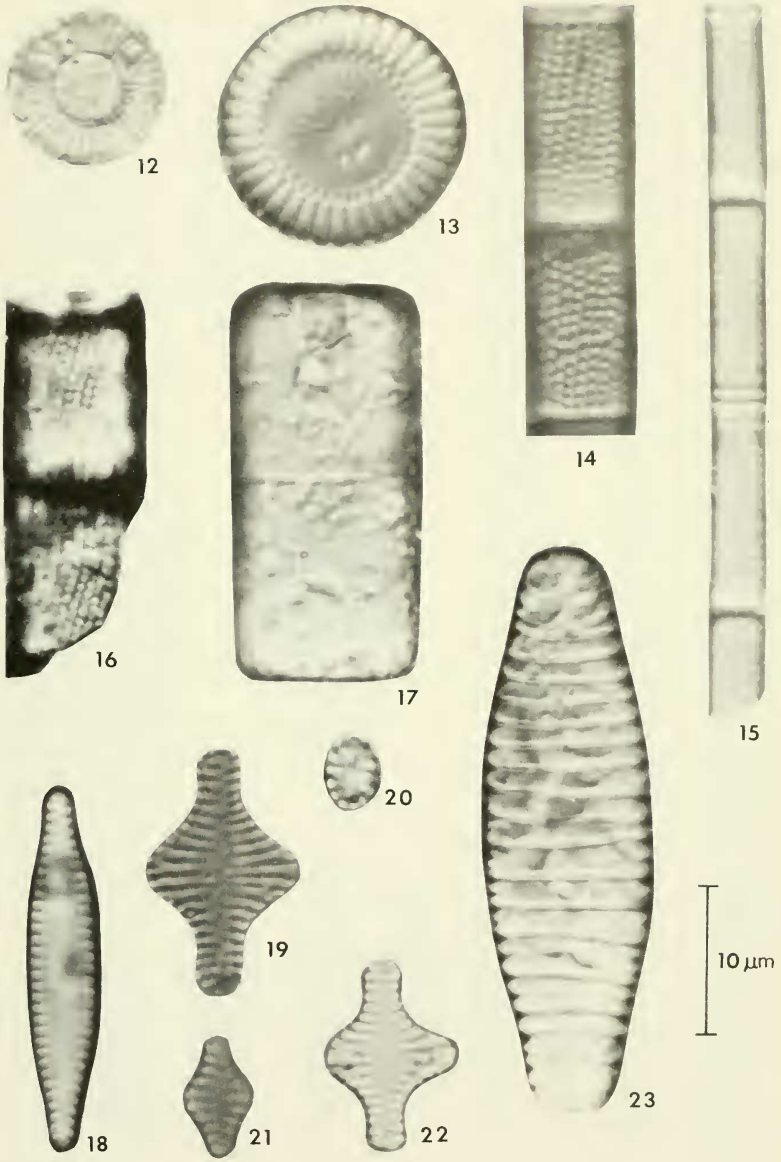
ORDER: NAVICULALES

Gyrosigma acuminatum (Kuetz.) Rabenhorst (Fig. 34). Cells 79–119 μm long by 12–19 μm wide; longitudinal striae 18 in 10 μm; transverse striae 17–18 in 10 μm (Patrick and Reimer 1966:314). Frequent in all parts of lake.

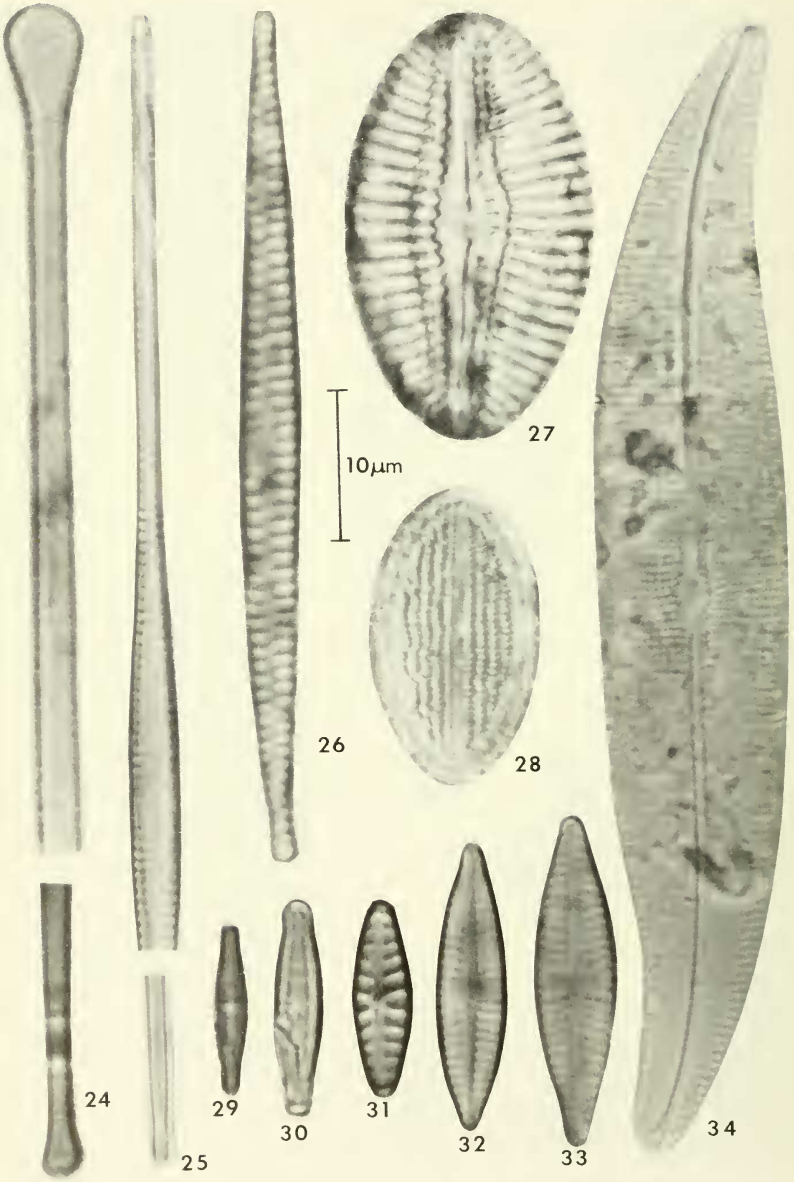
Pleurosigma delicatulum W. Smith. Cells 140–200 μm long by 16–22 μm wide; longitudinal and diagonal striae 19–22 in 10 μm (Patrick and Reimer 1966:336). Taxon characterized by its narrow, sigmoid shape and its angled striae. Rather common in Geneva and Goshen areas of lake, often as an epiphyte.

Diploneis smithii var. *dilatata* (M. Perag.) Boyer (Fig. 27). Cells 25–50 μm long by 16–25 μm wide; costae 8–10 in 10 μm (Patrick and Reimer 1966:411). Common throughout lake.

Navicula capitata var. *hungarica* (Grun.)



Figs. 12–23: 12, *Cyclotella kutzingiana*; 13, *Cyclotella meneghiniana*; 14, *Melosira granulata*; 15, *Melosira granulata* var. *angustissima*; 16, *Melosira italica*; 17, *Melosira varians*; 18, *Fragilaria brevistriata* var. *inflata*; 19, *Fragilaria construens*; 20, *Fragilaria construens* var. *venter*; 21–22, *Fragilaria construens*; 23, *Diatoma vulgare*. All figures are printed to the same scale.



Figs. 24–34: 24, *Asterionella formosa*; 25, *Fragilaria crotonensis*; 26, *Fragilaria vaucheria*; 27, *Diploneis smithii* var. *dilatata*; 28, *Cocconeis placentula* var. *linearis*; 29–30, *Achnanthes minutissima*; 31, *Navicula capitata* var. *hungarica*; 32–33, *Navicula cryptocephala* var. *veneta*; 34, *Gyrosigma acuminatum*. All figures are printed to the same scale.

Ross (Fig. 31). Cells 16–22 μm long by 5–6 μm wide; striae 7–10 in 10 μm (Patrick and Reimer 1966:537). In moderate numbers from all areas of lake.

Navicula cryptocephala var. *veneta* (Kuetz). Rabenhorst (Fig. 32, 33). Cells 10–21 μm long by 4–6 μm wide; striae 13–16 in 10 μm (Patrick and Reimer 1966:504). Frequent at all collecting stations.

Navicula graciloides A. Mayer (Fig. 36). Cells 27–34 μm long by 7–8 μm wide; striae 10–14 in 10 μm (Patrick and Reimer 1966:516). Frequent at all transects throughout collecting seasons. One of most common species in our studies.

Navicula salinarum var. *intermedia* (Grun.) Cleve (Fig. 37). Cells 34–37 μm long by 7–8 μm wide; striae 14–16 in 10 μm (Patrick and Reimer 1966:503). Frequently at many collecting localities.

Navicula tripunctata (Muell.) Bory (Fig. 35). Cells 35–55 μm long by 8–10 μm wide; striae 10–12 in 10 μm (Patrick and Reimer 1966:513). In moderate numbers from many collecting localities.

Caloneis amphisbaena (Bory) Cleve. Cells 68–79 μm long by 22–26 μm wide; striae 13–20 in 10 μm (Patrick and Reimer 1966:579). Frequently throughout lake.

Caloneis fenzlioides Cleve-Euhler (Fig. 38). Cells 86–96 μm long by 25–30 μm wide; striae 11–15 in 10 μm (Cleve-Euler 1955:88). Rather common at many collecting localities.

Amphora ovalis (Kuetz.) Kuetzing (Fig. 43). Cells 30–73 μm long by 6–15 μm wide; ventral striae 10–13 in 10 μm; dorsal striae 9–12 in 10 μm (Patrick and Reimer 1975:68). Abundant at most collecting sites throughout our studies.

Amphora ovalis var. *affinis* (Kuetz.) Van Heurck *ex* De Toni (Fig. 49). Cells 11–35 μm long by 7–10 μm wide; ventral striae 12–16 in 10 μm; dorsal striae 13–16 in 10 μm (Patrick and Reimer 1975:69). Taxon distinguished from nominate variety by its smaller size and rectangular central area. Common throughout lake.

Cymbella affinis Kuetzing (Fig. 44). Cells 27–47 μm long by 9–15 μm wide; ventral striae 9–11 in 10 μm; dorsal striae 10–12 in 10 μm (Patrick and Reimer 1975:57). Common throughout lake.

Cymbella prostrata (Berk.) Cleve (Fig. 46). Cells 28–55 μm long by 10–24 μm wide; ventral striae 7–9 in 10 μm; dorsal striae 8–11 in 10 μm (Patrick and Reimer 1975:46). Common only in northern part of lake.

Cymbella minuta var. *silesiaca* (Bleisch *ex* Rabh.) Reimer (Fig. 51). Cells 25–34 μm long by 10–12 μm wide; ventral striae 9 in 10 μm; dorsal striae 9–14 in 10 μm (Patrick and Reimer 1975:49). Very widespread and often common throughout lake.

Gomphonema angustatum (Kuetz.) Rabenhorst (Fig. 42). Cells 14–38 μm long by 6–7 μm wide; striae 11–16 in 10 μm (Patrick and Reimer 1975:125). Common throughout lake.

Gomphonema intricatum Kuetzing (Fig. 40). Cells 31–70 μm long by 7–12 μm wide; striae 10–13 in 10 μm (Patrick and Reimer 1975:134). Frequent at most collecting localities.

Gomphonema olivaceum (Lyngb.) Kuetzing (Fig. 41). Cells 12–36 μm long by 6–8 μm wide; striae 10–13 in 10 μm (Patrick and Reimer 1975:139). Common in all parts of lake.

Gomphonema ventricosum Gregory (Fig. 39). Cells 33–50 μm long by 9–11 μm wide; striae 12–13 in 10 μm (Patrick and Reimer 1975:137). Occasionally common in some samples.

ORDER: NITZSCHIALES

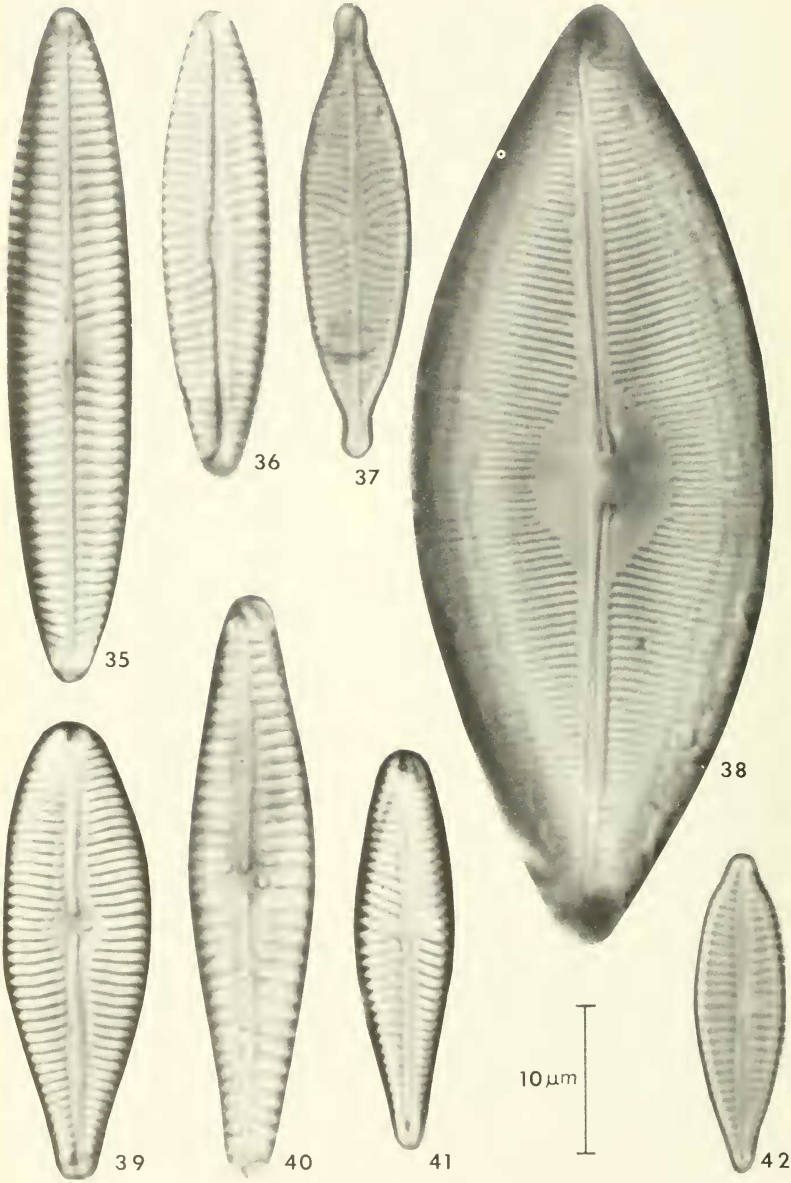
Nitzschia dissipata (Kuetz.) Grunow (Fig. 45). Cells 19–36 μm long by 4–5 μm wide; striae not resolvable; keel punctae 7–9 in 10 μm (Hustedt 1930:412). Collected frequently from all transects.

Nitzschia filiformis (W. Smith) Hustedt (Fig. 48). Cells 27–78 μm long by 5 μm wide; striae 32–34 in 10 μm; keel punctae 7–10 in 10 μm (Hustedt 1930:422). Frequent from most collecting localities.

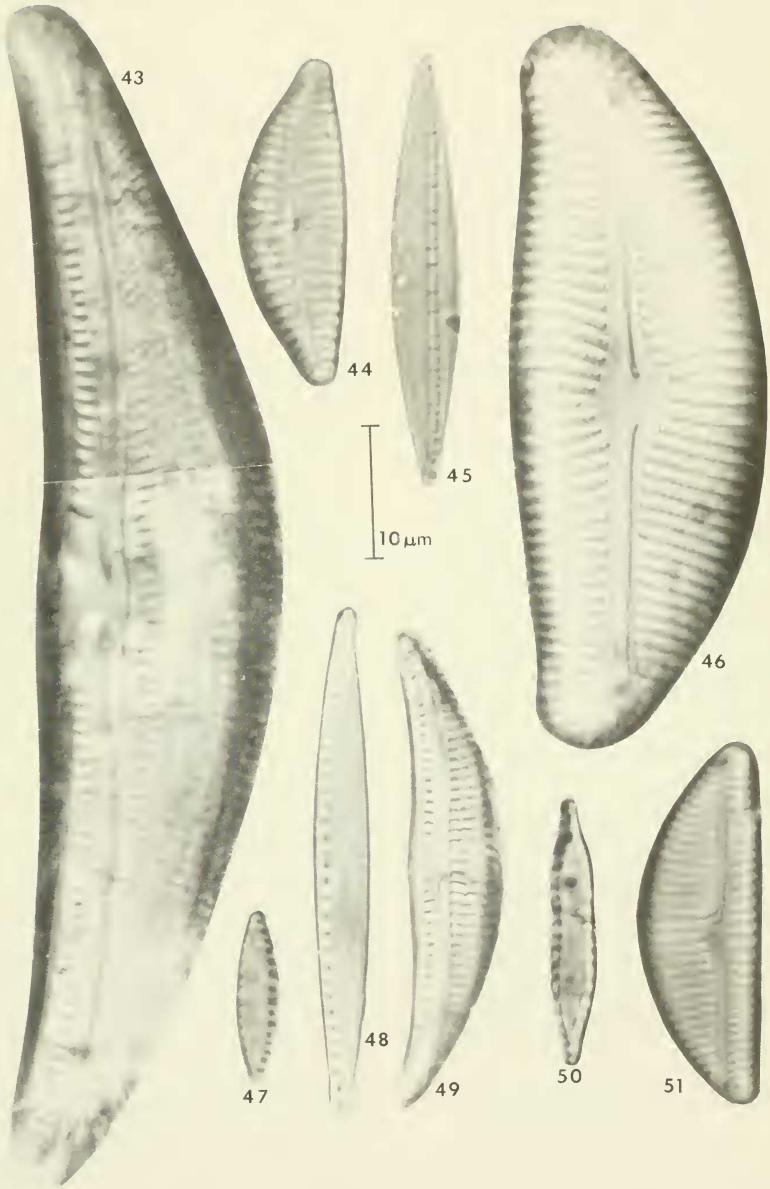
Nitzschia inconspicua Grunow (Fig. 47). Cells 6–15 μm long by 3–4 μm wide; striae 26–28 in 10 μm (Lange-Bertalot 1976: 265–266).

Nitzschia perminuta Grunow (Fig. 50). Cells 10–12 μm long by 3 μm wide; striae 24–35 in 10 μm; keel punctae 11–13 in 10 μm (Lange-Bertalot 1976:263). Collected frequently from all transects.

Nitzschia hantzschiana Rabenhorst. Cells 12–19 μm long by 2–3 μm wide; striae 20–24



Figs. 35–42: 35, *Navicula tripunctata*; 36, *Navicula graciloides*; 37, *Navicula salinarum* var. *intermedia*; 38, *Caloneis fenzlioides*; 39, *Gomphonema ventricosum*; 40, *Gomphonema intricatum*; 41, *Gomphonema olivaceum*; 42, *Gomphonema augustatum*. All figures are printed to the same scale.



Figs. 43–51: 43, *Amphora ovalis*; 44, *Cymbella affinis*; 45, *Nitzschia dissipata*; 46, *Cymbella prostrata*; 47, *Nitzschia inconspicua*; 48, *Nitzschia filiformis*; 49, *Amphora ovalis* var. *affinis*; 50, *Nitzschia perminuta*; 51, *Cymbella minuta* var. *silesiaca*. All figures are printed to the same scale.

TABLE 2. Algae standing crop in Utah Lake at selected sites along three permanent transects during the summer of 1974. The numbers represent total algal cells, colonies, and filaments per liter.

	Goshen Bay				Transect	
Date	A	B	C	D	A	B
13 June 1974	1,007	1,702	2,417	1,778	10,528	619
20 June 1974	26,875	250	2,344	13,111	14,800	13,444
3 July 1974	24,917	48,500	39,250	78,667	17,506	30,042
8 July 1974	479,444	146,500	99,000	–	180,167	278,833
18 July 1974	629,167	216,250	260,500	203,333	922,222	710,416
27 July 1974	449,167	412,500	179,722	355,000	513,194	353,472
7 August 1974	59,815	30,000	20,375	122,917	1,111,667	280,000
15 August 1974	–	–	226,562	2,943,750	193,056	173,177

in 10 μm; keel punctae 9–11 in 10 μm (Hustedt 1930:415). Frequent from all collecting sites.

Division: Euglenophyta

ORDER: EUGLENALES

Euglena gracilis Klebs (Fig. 53). Plant unicellular and free swimming; cells metabolic, short fusiform to ovoid; chloroplasts many, discoid, distributed through cell; cells 20–22.5 μm in diameter, 37.5–50 μm long, may stretch to 75 μm long (Prescott 1962:393). Our most common *Euglena*. Abundant at mouth of Provo River, usually found with *E. ehrenbergii* and *E. oxyuris*.

Division: Pyrrophyta

ORDER: PERIDINIALES

Ceratium hirundinella (Muell.) Dujardin (Fig. 54). Plant unicellular and solitary; cells narrowly fusiform with one apical horn and 2–3 stouter and shorter basal horns; apical horn straight, truncately flattened at apex; cells 30–72 μm wide, 100–400 μm long (Prescott 1962:437). Although rare in early June, one of dominant plankters throughout remainder of summer. Often abundant enough to color water muddy-brown and to plug plankton nets.

Division: Cyanophyta

ORDER: CHROOCOCCALES

Microcystis aeruginosa Kuetz. *em.* Elenkin (Fig. 55, 56). Colony spherical when young, becoming irregularly lobed and clathrate when mature; cells spherical and crowded within hyaline gelatinous matrix; cell contents blue green, highly granular, with conspicuous pseudovacuoles; cells 3–4 μm in diameter (Prescott 1962:456). Common to abundant in most plankton samples.

ORDER: NOSTOCALES

Anabaena spiroides var. *crassa* Lemmermann (Fig. 57). Trichomes spiral, solitary or entangled; cells spherical, pale blue green in color; cells 10–12 μm in diameter; heterocysts subspherical, 10 μm in diameter, 12 μm long; akinetes oblong, 20 μm in diameter, 25–30 μm long (Prescott 1962:518). Can be confused with *A. flos-aquae* but is less blue, less granular, more regularly coiled, and with larger cells. Abundant to common in most plankton samples. Occasionally forms fairly large blooms.

Aphanizomenon flos-aquae (Lemm.) Ralfs (Fig. 58). Trichomes parallel, united in bundles or flakes to form macroscopic aggregates; apices broadly rounded, not attenuate; cells 5–6 μm in diameter, 6–8 μm long, with numerous conspicuous pseudovacuoles; heterocysts oblong or cylindrical (Prescott 1962:528). Usually most abundant and conspicuous summer plankter in Utah Lake.

QUANTITATIVE SAMPLING

We have also performed quantitative sampling of the algal standing crop of Utah Lake. Our most complete data were collected during the 1974 collecting period. These data show that the standing crop of the lake was low during the spring and early summer (Table 2). At that time community diversity was high and the standing crop was divided

Table 2 continued.

and site							
Boat Harbor			Geneva				
C	D	E	A	B	C	D	E
1,424	1,448	625	647	719	1,971	743	5,590
—	2,055	2,311	5,750	17,500	5,939	144,667	—
35,625	27,778	51,250	293,499	19,850	41,917	16,958	5,944
263,833	174,333	104,667	857,016	954,384	199,653	120,500	75,333
917,361	811,111	402,083	—	119,666	906,249	468,750	568,750
351,389	242,014	203,819	277,083	457,291	—	—	—
114,583	280,417	74,167	605,556	701,042	300,694	6,333,333	102,292
284,722	591,667	450,000	15,833,332	6,944,444	22,750,000	77,816,656	2,133,333

between several taxa (Whiting et al. 1978). As the summer progressed community diversity decreased but standing crop increased. By late summer the standing crop was composed of essentially two species, *Aphanizomenon flos-aquae* and *Ceratium hirundinella*.

The high diversity as measured by the total number of species occurring in the lake coupled with the high late summer biomass leads us to conclude that Utah Lake represents a somewhat unique ecosystem. It is similar to certain other saline eutrophic systems in North America and Australia. Further studies on the algae of this system are presently underway.

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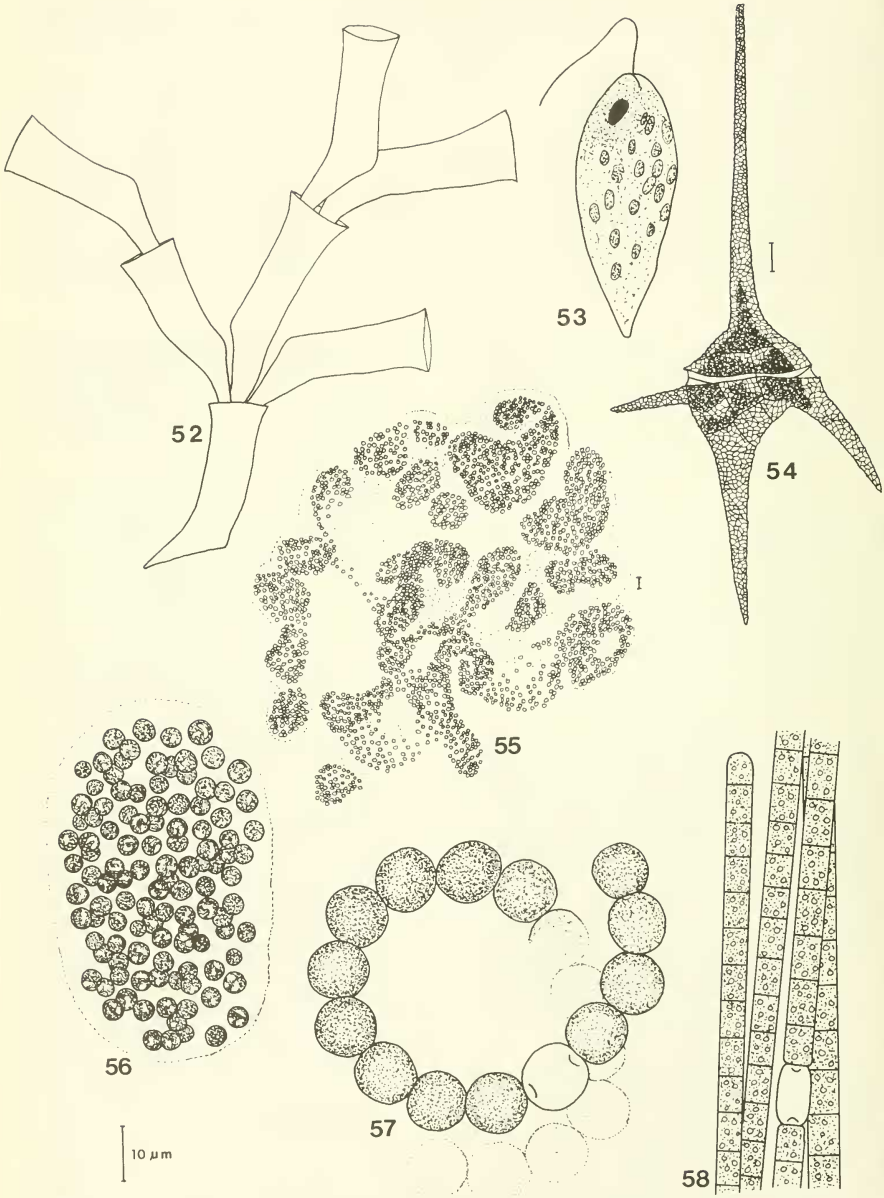

Figs. 52–58: 52, *Dinobryon divergens*; 53, *Euglena gracilis*; 54, *Ceratium hirundinella*; 55–56, *Microcystis aeruginosa*; 57, *Anabaena spiroides* var. *crassa*; 58, *Aphanizomenon flos-aquae*. All figures except 54 and 55 are drawn to the same scale. Scales provided represent 10 µm.